Idaho National Engineering and Environmental Laboratory

EVALUATION OF THERMOPHILIC BACTERIA FOR SULFIDE MINERAL HEAP LEACHING

Evaluation of the use of thermophilic bacteria, their advantages and shortcomings, and establishment of technology for on-site culturing of the inoculum suspension should be determined to better understand current sulfide mineral heap leaching, and identify methods for enhancing the efficiency of the process. This project includes a comparison of conventional mesophilic mineral-oxidizing bacteria with moderate and extreme hermophiles. The project extends the knowledge base for the use of bacterial catalysts in the heap leach process, leading to better design and control parameters for heap leach operations. This will be necessary to make the processing of large volumes of lower grade and more complex ores (a challenge facing the U.S. mining industry in particular) economically feasible in the future.

Background:
Conventional metallurgical processing of refractory precious metal ores and concentrates and base metal concentrates requires the use of energy intensive smelters, roasters and pressure autoclaves. The cost of the technologies limits their use to processing higher-grade, higher value ores and concentrates. Alternatively, the application of biotechnology to mineral processing offers a cost effective, efficient, safe and environmentally friendly way to treat either higher value concentrates or lower value whole ores. Microbial processes can be used with inexpensive heap reactors for either extraction of base metals or pretreatment of refractory precious metal ores. Some recent publications describe the importance that new, economical, and more environmentally-benign approaches to large scale processing of low grade, complex ores will play in ensuring stable supplies of metals in the future. In some parts of the world (Australia, New Zealand, Ghana, Brazil, and South Africa), biooxidation of gold-bearing ores is already well accepted, and the reduced cost of the biological process, as well as improved unit operations are now challenges. Recent experiences with sulfide mineral heap leaches by both INEEL and industry researchers have demonstrated the generation of high internal temperatures in heaps at relatively low sulfide-sulfur concentrations. Conventional biooxidation bacteria die off at these high temperatures (>45° C). Thermophilic bacteria, which can exist at temperatures much greater than 45° C, can oxidize sulfide minerals under conditions which would be expected to kill, or at least inactivate, the mesophilic bacteria. By developing a better understanding of how the temperature of the heap leaching process influences microbial populations, identifying thermophilic bacteria which can tolerate or thrive at higher temperatures, and evaluating the impact of inoculating heaps with these bacteria, more efficient processes can be established.

Project Objective: To evaluate the influence of temperature on microbial populations in sulfide mineral heap leach simulations (tank and column studies) and determine the relative importance of thermophilic species on mineral dissolution and metal value recovery.

Impacts of Proposed Research:
The mining industry recognizes the importance of biotechnology for economically processing ores and concentrates. Commercial application of biotechnological ore processing is a reality for base

and precious metals recovery. However, a basic understanding of the complex microbiological ecosystem in operating tank and heap reactors is at a rudimentary level, particularly with regard to the thermophilic microbe species. Only a comprehensive definition of the microbiological component of the metallurgical processing system can facilitate better controls and economic improvements of the commercial scale applications.

Specialized Experience of the Team at INEEL:

INEEL scientists have performed fundamental studies on the major classes of acidophilic bacteria in acidic mining environments for over a decade. Much of this work supported the former U.S. Bureau of Mines programs in biological leaching of sulfide minerals, and most recently, the Bureau's in situ mining program. The multidisciplinary composition of the Biotechnology Department at INEEL provides team members with expertise ranging from microbiology, biochemistry, and molecular biology, to biochemical engineering. Virtually all members of the team have participated in mining-related projects for the USBM and various mining companies. Recent industry-sponsored work and internally funded projects have focused on the optimization of biologically mediated chalcopyrite heap leaching.

For information contact:

Jerry L. May
e-mail: jlm@inel.gov
Phone: (208) 526-6674

John Alexander
e-mail: jala@inel.gov
Phone: (208-) 526-0849